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AN EVALUATION OF THE PINE BUTTERFLY OUTBREAK IN THE BITTERROOT AND MISSOULA AREA

by

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The pine butterfly, *Neophasia menapia* (Felder and Felder), has been at epidemic levels in the Bitterroot and Missoula areas since 1969 (Ciesla et al. 1971) (Bousfield and Meyer 1972). Large flights of butterflies have aroused public attention, and many landowners are concerned about possible tree mortality resulting from defoliation by the larvae.

Biological evaluations have been conducted to predict infestation trends and predator and parasite activity has been observed for the past 2 years (Bousfield and Ciesla 1971). Aerial surveys have monitored the outbreak and delineated the areas and intensities of infestation.

The purpose of this evaluation is to update the pine butterfly situation and document some of the biological data collected. The evaluation consists of two parts: (1) forecasting pine butterfly populations, and (2) activity of natural enemies.

METHODS

Forecasting pine butterfly populations.--A sampling method to predict infestation trends and defoliation levels has been developed (Bousfield and Ciesla 1971), and modified to account for changes in defoliation levels as the infestation progresses. The prediction model is based on estimating the number of viable pine butterfly eggs that overwinter on a 5-inch branch sample. In each area a total of six 5-inch midcrown branch samples are collected from each of ten trees to comprise a sample base of 60 branches. Eggs are counted and both total and viable eggs tallied. Viable eggs can be separated from nonviable by their green color and contain yolk material, whereas nonviable eggs are white and the contents are dry.

Defoliation is assessed by classifying trees into defoliation indexes which range from 0 (negligible defoliation) to 4 (severe defoliation). A total of 20 trees, in the same area eggs were collected, are classified to determine the average defoliation index for an area. The following table can be used to convert defoliation index to percent defoliation.

Table 1.--Pine butterfly defoliation index

Defoliation index		Percent defoliation range
0	negligible	0 - 11
1	light	12 - 37
2	moderate	38 - 62
3	heavy	63 - 85
4	severe	86 - 100

A multiple regression equation was developed to predict defoliation using 1971-1972 data. Two variables which influence the degree of defoliation are: (1) the number of eggs per 5-inch branch sample, and (2) the amount of defoliation already present in the area. Defoliated trees may have fewer eggs but feeding will be concentrated on the remaining needles the following year. Therefore, the amount of defoliation present, expressed as a percent of trees with visible defoliation, is quite an important variable needed to predict the following year's defoliation. The correlation coefficient "r" was equal to .984 in the regression analysis.

The regression equation is:

$$Y = -.0659 + .0141 (X_1) + .02 (X_2)$$

Where Y = defoliation index

X_1 = mean eggs per 5-inch branch sample

X_2 = percent of trees with visible defoliation

Activity of natural enemies.--The percent of parasitism in the pine butterfly population was estimated by collecting at least 200 prepupae or pupae from five areas and placing them in rearing containers in the laboratory. Rearing containers were 5-gallon ice cream cylinders with 5-dram vials attached as a light source. Parasites were counted as they emerged. Parasite identificaion was made by insect taxonomists at the U.S. National Museum.

RESULTS AND DISCUSSION

Potential for 1973.--Data gathered in September shows that the infestation will continue in 1973. The infestation has expanded from 10,000

acres in 1971 to 40,000 acres of aerially visible defoliation in 1972 (Fig. 1). Although egg counts are lower in 1972 than in 1971 (Table 2), we expect defoliation to continue at about the same level or higher in 1973 because many areas are currently defoliated, thus the larvae will be concentrated on fewer needles (Table 3).

An analysis of branch samples collected from defoliated areas showed that fewer eggs occurred on severely defoliated trees than on lightly defoliated trees within the same stand. It was observed that eggs are seldom deposited on partially eaten needles.

Natural enemies.--A parasitic wasp, *Theronia atalantae* Poda, has been attributed to causing the collapse of past pine butterfly infestations. A fly, *Agria affinis* (Fall.), was an important pupal parasite in a 1950-1954 infestation. A pentatomid predator, *Podisus placidus* Uhler, was reported in large numbers during a 1922-1923 outbreak (Cole 1956).

Though systematic measurements of the parasite and predator populations have not been conducted annually, it is apparent from field observations that their numbers have substantially increased each year of the outbreak.

There is a diverse complex of natural agents working on the current infestation. To date, three species of predatory bugs of the family Pentatomidae have been observed feeding on pine butterfly eggs, larvae, and pupae. At least three species of parasitic wasps and three parasitic flies have been reared from pine butterfly pupae. The identification of several of these insects is still pending. The ones currently identified are *T. atalantae, Apateticus bracteatus* (Fitch), *P. placidus* Uhler, *Podisus serieventris* Uhler, and two dipterons--a tachinid, *Ceromasia auricaudata* Tsn., and a sarcophogid, *Agria housei* Shewell.

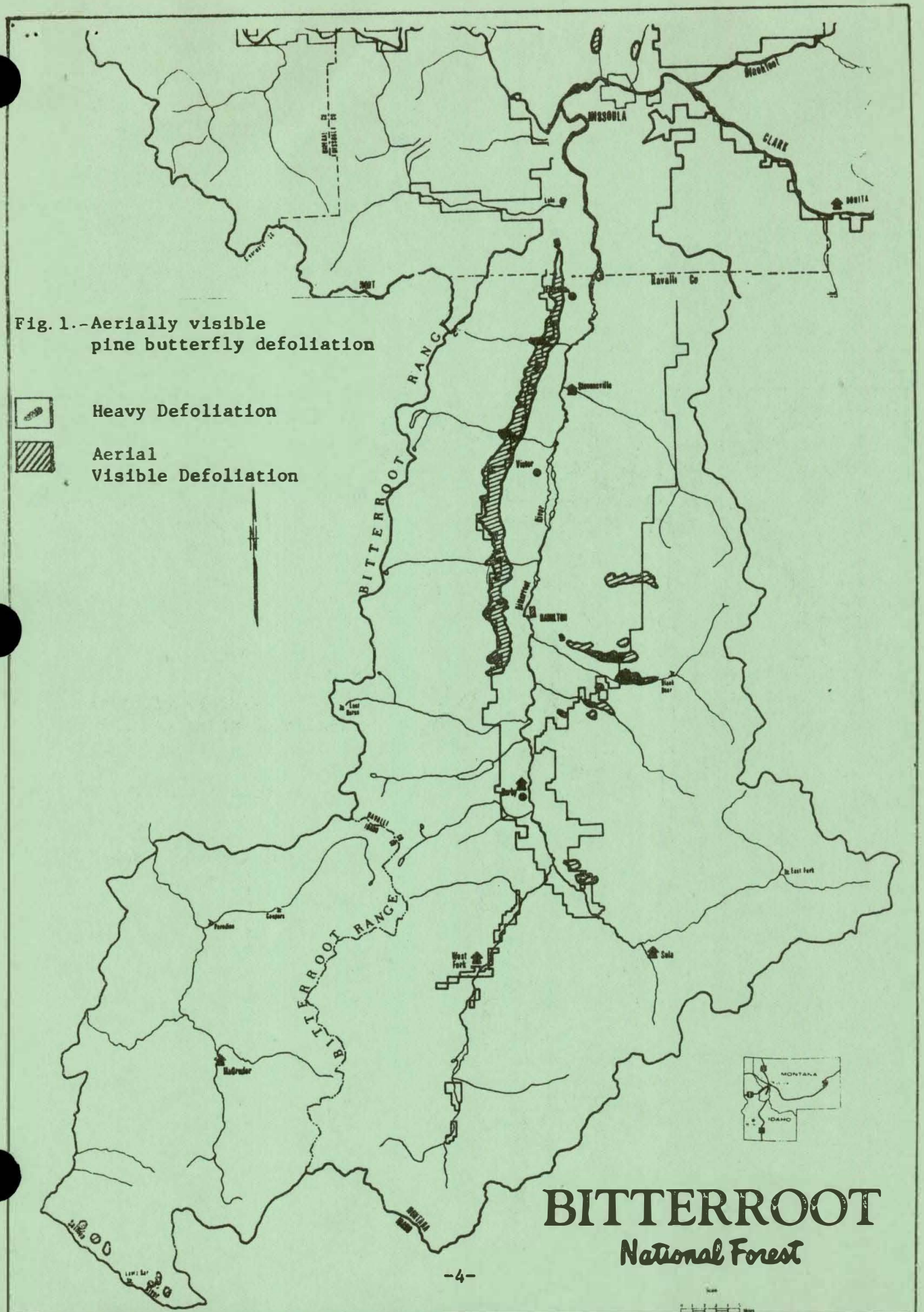

Fig. 1.-Aerially visible pine butterfly defoliation

Heavy Defoliation

Aerial Visible Defoliation

Table 2.-- Mean viable pine butterfly egg counts for 1970, 1971 and 1972 per 5-inch branch sample

	Year		
	1970	1971	1972
Bitterroot NF			
Laird Cr.	*	+	3.33
Sleeping Child	*	+	6.78
Lake Como	*	+	.83
Skalkaho A	7.78	28.26	8.75
Skalkaho B	*	+	3.91
Burnt Fork	3.32	+	19.98
Antrim Pt.	0.0	+	12.16
Lost Horse Cr.	7.58	33.87	12.60
Roaring Lion Cr.	8.22	32.53	7.93
Blodgett	41.68	33.01	21.10
Cow Cr.	46.54	54.11	36.57
Sheafman Cr.	*	25.88	28.36
Fred Burr Cr.	5.64	21.45	17.54
Big Cr.	34.76	50.91	20.10
St. Mary's Pk. Rd.	*	+	9.83
Bass Cr.	46.96	30.06	7.13
Sweeney Cr.	*	+	10.81
Carlton Cr.	6.56	37.38	19.90
Lolo NF			
Mormon Pk. Rd.	14.94	40.30	15.06
Lolo Cr.	.26	.33	.96
Blue Mt.	1.32	3.20	1.51
Rattlesnake	16.00	34.45	13.18
Grant Creek	22.02	44.73	10.24
Edith Cr.	0.0	1.68	1.08

* not sampled in 1970
\+ not sampled in 1971

Table 3.--1973 predicted defoliation for areas sampled in the Bitterroot and Lolo National Forests

Area	1972 Defoliation index	1973 Predicted defoliation index	1973 Predicted percent defoliation	Trend
Bitterroot NF				
Laird Cr.		0	0	*
Sleeping Child		0	0	*
Lake Como		0	0	*
Skalkaho A	.4	.8	22	increase
Skalkaho B		.8	22	*
Burnt Fork		.2	3	*
Antrim Pt.		.1	1	*
Lost Horse Cr.	.2	.5	12	increase
Roaring Lion Cr.	.2	.4	10	increase
Blodgett	2.2	2.0	49	decline
Cow Cr.	1.8	2.1	51	increase
Sheafman Cr.	.6	1.3	32	increase
Fred Burr Cr.	.2	.5	12	increase
Big Creek	2.1	2.2	54	static
St. Mary's Pk. Rd.		1.4	35	*
Bass Creek	.9	1.4	35	increase
Sweeney Cr.		1.0	25	*
Carlton Cr.	.5	1.1	27	increase
Lolo NF				
Mormon Pk. Rd.	.8	1.5	37	increase
Lolo Creek	.0	0	0	
Blue Mt.	.0	0	0	
Rattlesnake	.5	.2	4	decrease
Grant Cr.	.6	1.1	27	increase
Edith Cr.	.0	0	0	

* Areas not sampled in 1971 to determine trend

It appears the most common parasite is an unidentified dipteron that has not emerged as an adult to date. Results of the parasite rearing are shown in Table 4.

Table 4.--Pine butterfly parasite emergence data

Area	No. of butterfly pupae collected	Emerged parasites *T. atalantae* ♀	Emerged parasites *T. atalantae* ♂	Emerged parasites Others	Total percent parasites emerged
Bass Ck.	241	8	40	1	20
Cow Ck.	207	7	20	6	16
Sheafman Ck.	210	7	20	5	15
Skalkaho Ck.	228	12	94	3	48
Grant Ck.	208	10	86	2	48
Total	1094	44	260	17	29

Parasitism figures of Table 4 do not represent total parasitism, for the common dipterous parasite never emerged as an adult, and its larvae were not counted. These figures probably are not representative of the entire area from which they were collected for the butterfly pupae were predominantly collected from the lower branches of the larger trees. It was later found that percent parasitism varied with pupation site. These differences are shown in Table 5.

Table 5.--Pine butterfly parasitism in relationship to pupation site

Collection site	No. of pupae examined	Percent parasitism
Lower dead branches of large ponderosa pines	300	71
Lower trunk of large ponderosa pines	300	37
Branches of small ponderosas (trees less than 3 feet tall)	300	16
Snowberry underbrush	300	16

The pupae in Table 5 were all collected July 25, 1972 in a small area in Sweeney Creek. By this date about 95% of the butterflies had pupated. Some parasitism was still occurring. Parasitism was determined by examining dissected pupae for parasites.

Some disease activity has been observed in the butterfly population. A fungus, *Aspergillus* probably *flavus*[1/], killed many of the butterfly larvae that were being laboratory reared. However, it is suspected this pathogen is only significent under laboratory conditions and will not affect the butterfly outbreak.

Dr. C. G. Thompson, insect pathologist, Pacific Northwest Forest and Range Experiment Station, has identified a virus pathogen associated with the butterfly larvae and feels it may ultimately contribute to the collapse of the infestation.

The final impact of this infestation is still unknown. It is expected that many of the trees that are severely defoliated will die. During an outbreak in central Idaho in the early 1920's Evenden (1940) marked 100 mature trees and followed their development for 13 years after the infestation collapsed. Eighty-four of the trees were rated as being severely defoliated. Of these, 14.3 percent died from defoliation alone, and another 16.7 percent died from defoliation and subsequent attacks of bark beetles. No mortality occurred in the moderate and lightly defoliated trees. He found that severely defoliated trees did not die all at once but died gradually over the 13-year period. Over 75 percent of the dead trees died within 6 years of peak defoliation. No trees died the year after peak defoliation.

If the Bitterroot infestation follows the pattern of the 1922 outbreak, and assuming peak defoliation is 1972 and 1973, tree mortality will not be significant until 1974.

Currently a damage survey is in progress to measure the effect of the defoliation in terms of tree mortality and reduced increment. This survey will continue for at least the next 5 years.

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1/ Identified by Dr. C. G. Thompson, Pacific Northwest Forest and Range Experiment Station, USFS, Corvallis, Oregon.

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